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MENTAL FATIGUE IN FOOTBALL

By

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This thesis is presented for the award of a Doctor of Philosophy (Sports Medicine) from the Medical Faculty, Saarland University, Saarbrücken, Germany, and University of Technology Sydney (UTS), Australia.

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Chris Thompson declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy in the Sport and Exercise Faculty at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.

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I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree at any other academic institution except as fully acknowledged within the text. This thesis is the result of a Collaborative Doctoral Research Degree program with Saarland University, Germany.

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The format of this thesis is aligned with the ‘Thesis by Publication’ format as per the standards of both Saarland University and the University of Technology Sydney.

LIST OF PUBLICATIONS RELEVANT TO THE THESIS

Published:

Smith, M. R., Thompson, C., Marcora, S. M., Skorski, S., Meyer, T., & Coutts, A. J. (2018). Mental fatigue and soccer: current knowledge and future directions. *Sports Medicine*, *48*(7), 1525-1532.

Thompson, C. J., Fransen, J., Skorski, S., Smith, M. R., Meyer, T., Barrett, S., & Coutts, A. J. (2018). Mental fatigue in football: Is it time to shift the goalposts? An evaluation of the current methodology. *Sports Medicine*, *49*(2), 177-183.

Thompson, C. J., Noon, M., Towlson, C., Perry, J., Coutts, A. J., Harper, L. D., Skorski, S., Smith, M. R., Barrett, S., Meyer, T. Understanding the presence of mental fatigue in English academy soccer players. Journal of Sports Sciences, 1-7.

Thompson, C., Fransen, J., Beavan, A., Skorski, S., Coutts, A., & Meyer, T. (2020). Understanding the influence of a cognitively demanding task on motor response times and subjective mental fatigue/boredom. *Brazilian Journal of Motor Behavior*, *14*(01), 33-45.

Under review:

Understanding the cognitive demands experienced by professional soccer players: A perspective of English Football League and National League players. Chris J Thompson, Chris Towlson, John Perry, Aaron J Coutts, Mark Noon, Liam D Harper, Sabrina Skorski, Mitchell R Smith, Steve Barrett & Tim Meyer. (under review with Research Quarterly for Exercise and Sport)

Understanding the presence of mental fatigue in elite female football. Chris J Thompson, Andy Smith, Aaron J Coutts, Sabrina Skorski, Naomi Datson, Mitchell R Smith & Tim Meyer. Qualitative Research in Sport, Exercise and Health (in press with Research Quarterly for Exercise and Sport)

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LIST OF ABBREVIATIONS

ACC – Anterior cingulate cortex

AX-CPT – AX Continuous Performance Task

BET – Brain endurance training

BRUMS – Brunel Mood Scale

CCA – Continuous cognitive activity

dRPE – differential Rating of Perceived Exertion -

DL-PFC – Dorsolateral prefrontal cortex

ECG – Electrocardiogram

EEG – Electroencephalography

ERN – Error-related negativity

ERP – Event-related potential

fNIRS – Functional near-infrared spectroscopy

HIA – High intensity activity

HRV – Heart rate variability

LC-NE – Locus-coeruleus norepinephrine

LIA – Low intensity activity

LSPT – Loughborough soccer passing test

LSST – Loughborough Soccer Shooting Test

MVC – Maximal voluntary contraction

NE – Norepinephrine

POMS – Profile of Mood State

RPE – Rating of Perceived Exertion

SART – Sustained attention to response task

SNR – Signal-to-noise ratios

VAS – Visual analogue scale

Yo-Yo IR1 – Yo-Yo intermittent recovery level 1

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ABSTRACT

INTRODUCTION: Mental fatigue is a psychobiological state experienced following exposure to cognitively demanding tasks. Anecdotal evidence shows that mental fatigue can impair football (soccer) performance based on the cognitive demands of match play, fixture congestion, receiving high volumes of tactical information and internal and external pressures to succeed. In six original investigations, induced mental fatigue has negatively influenced football specific skill, physical, tactical and decision-making performance. However, these studies share consistent limitations, which include the use of cognitive tasks with low ecological validity to induce mental fatigue, as well as the recruitment of sub-elite or recreational players. Further research is required to address the limitations of the current research, investigate the relevance of current methods employed to induce mental fatigue, and to understand the true cognitive demands experienced by elite level football players. Therefore the aims of this thesis were as follows: i) to evaluate the applicability of the current mental fatigue research to elite football settings, ii) understand the relevance of the modified Stroop task in inducing mental fatigue, plus its impact on using implicit and explicit information, and iii) use a mixed methods approach to elucidate cognitive demands and influence on performance in elite male, female and academy football players.

METHODS: i) A literature review was conducted to understand the collective impact of induced mental fatigue on football specific performance. ii) A current opinion article critically examined the methodology of the current mental fatigue in football research, with recommendations provided for future study designs. iii) The modified Stroop task was assessed for its impact on using implicit and explicit cues, plus boredom, a construct similar to the demands of mental fatigue. In addition, the impact of a brief rest period from cognitively demanding activity was measured. iv) English Football League and National League players completed an online survey which investigated the impact of football and lifestyle specific cognitive activities on perceived mental fatigue and impact on performance. v) An additional survey was completed by elite English academy football players (U14 – U23) which explored the effects of football and adolescent specific activities on perceived mental fatigue and impact on performance. vi) Focus group interviews explored the psychological demands of elite female football.

RESULTS: i) Mental fatigue studies have used repetitive cognitive tasks with low contextual interference which do not resemble the real-life cognitive demands (i.e. high contextual interference in a dynamic environment) of elite football. ii) The modified Stroop elicits high subjective mental fatigue and boredom ratings which significantly reduce (but not to baseline levels) following a short break. iii) In elite English Football League/National League and academy football, any cognitive tasks completed are short and frequent (intake of tactical information, media commitments, travel) with a negligible influence on perceptions of mental fatigue and performance. A contrast was evident in elite female football, where travel, intake of excessive tactical information and internal pressure to succeed were commonly cited as psychological demands.

DISCUSSION: Mental fatigue in football may be a transient sensation that subsides following a rest period. Due to predominantly extensive experience in football, elite football players may become accustomed to daily cognitive stressors, or the tasks completed may be too brief compared to the protocols that have been applied in studies to mental fatigue. Conversely mental fatigue may be more prevalent in environments where football is accompanied by additional commitments (full time work/education). The previous research inducing mental fatigue immediately prior to task performance may also be an irrelevant time period where mental fatigue is experienced in elite settings, likely due to high arousal induced by caffeine intake, listening to music and the players

general intrinsic motivation to play. Future research is required to investigate the impact of other time periods (e.g. latter stages of a match, 24 hours post-match) and longitudinal durations (i.e. daily monitoring throughout a season) and subsequent risk of mental fatigue.